LABORATORY Spotlight
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Successes and Challenges of Initial Testing of the Wide Bore 900 MHz Magnet

900 MHz MAGNET

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The NHMFL has designed, fabricated, and is presently performing initial testing of a wide bore 900 MHz magnet system to be installed at the Tallahassee, Florida laboratory. The wide bore feature of the NHMFL design allows more options for NMR experiments and will be able to accommodate future high field Nb_3Sn or high temperature superconducting coils capable of boosting the central field to greater than the 23.5 T required for 1 GHz.

The NHMFL wide bore 900 MHz NMR magnet system has successfully completed its first bucket test, which has provided valuable information about the performance of the magnet system as a whole. As described in last summer's *NHMFL Reports*, the bucket test is intended to characterize the maximum operating field, the persistence, and the field homogeneity as well as to qualify the operation of all the associated subsystems such as the quench detection and protection. The bucket test is designed to allow easy access to the magnet in the event that modifications are required before installing the magnet into the final cryostat, which is a completely welded, vacuum tight vessel.

Several successes and several challenges were encountered during the initial bucket test. The first major event of the test was a quench of the magnet at approximately 380 MHz (8.9 T), which began as our first challenge and resulted in a successful tuning of the quench detection system. Inspection of the data captured during the quench revealed that the quench protection system was triggered from a voltage spike on the coil. The recorded data showed that the voltage spike was decreasing in amplitude at the time the quench protection triggered the heaters in the superconducting coils, indicating that the voltage spike did not represent a true coil quench but was due to a non-quench inducing coil motion event. After a thorough study of the problem and subsequent redesign of the triggering electronics, the quench detection system was reconfigured to allow the occurrence of similar and slightly larger voltage spikes without triggering the quench protection system. Further 4.2 K testing yielded at least six more spikes of similar magnitude that would have triggered a quench, but due to the reconfigured detection system, no false quenches were activated. Success!

After reconfiguration of the quench detection electronics, the coil was charged to approximately 300 MHz and field maps were taken to verify the operation of the eight sets of superconducting shims and measure their strength in comparison to design values. The results of these tests confirmed that seven of eight shims worked as expected, and that the field strengths of all eight shims were as designed. Furthermore, the field maps also indicated that the superconducting shim strength—in combination with the room temperature shims—will be able to achieve the final homogeneity specification of less

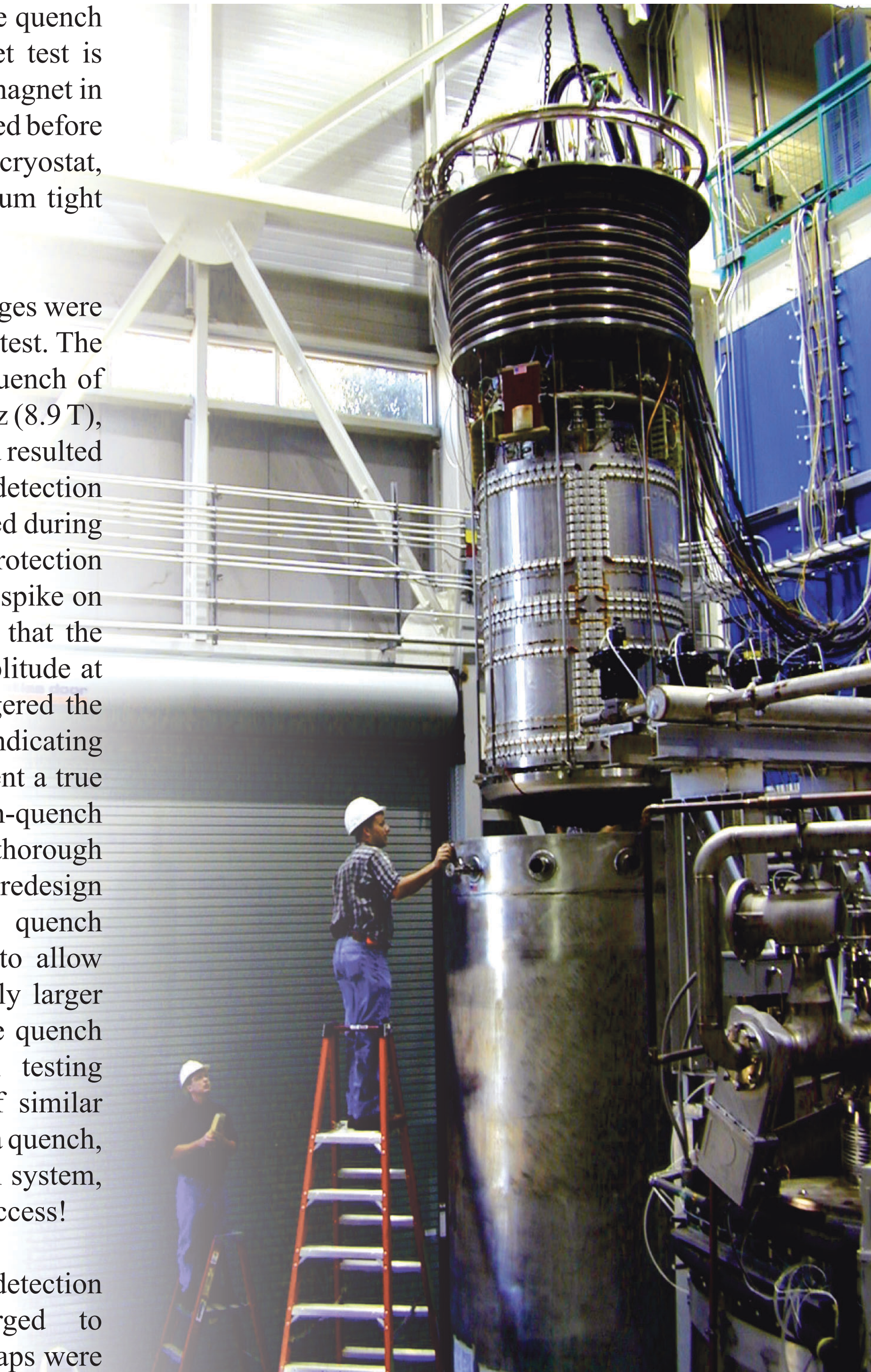

Figure 1. The magnet assembly is inserted in the bucket cryostat on October 26, 2001, in preparation for the initial bucket test.

than 1 ppb over a 4 cm DSV. Success! The superconducting shim that didn't work as expected still met its field strength requirement, but could not be charged as quickly as the others. Modifications made to the switch electronics after the magnet was warmed up are expected to correct the degraded charging capability of this shim.

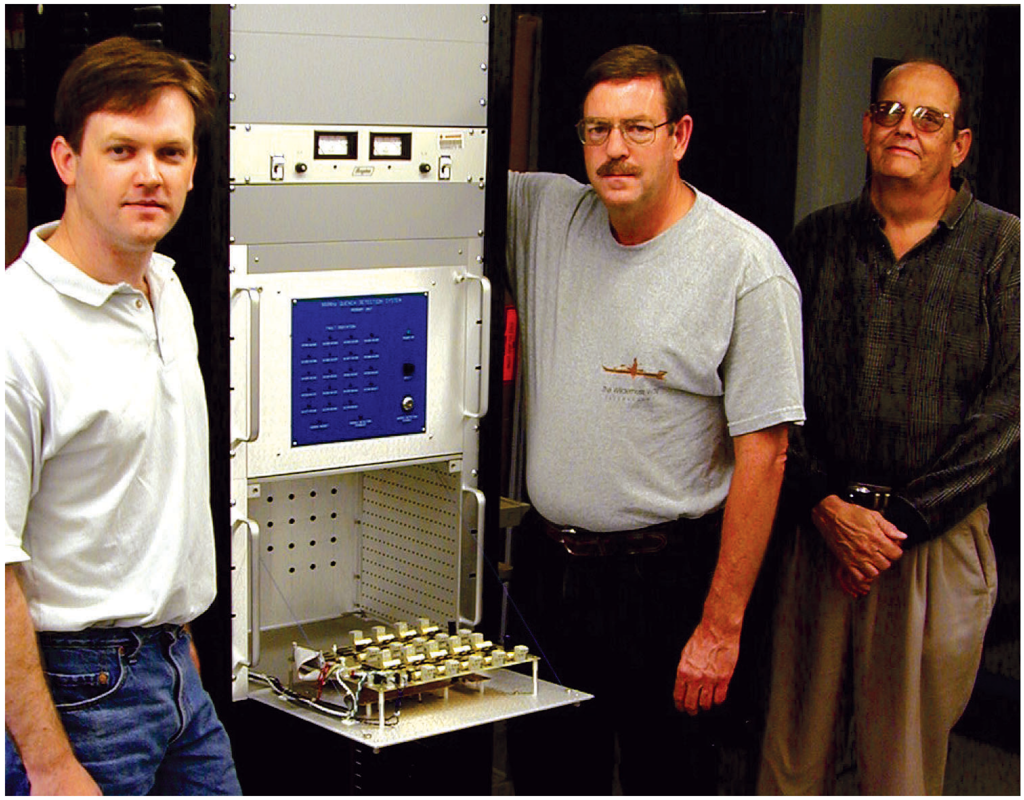

Figure 2. Nearly all the high voltage electronics, including the quench detection and protection system shown here were the responsibility of Andy Powell, Lee Bonninghausen, and Peter Murphy, standing from left to right.

Following the field mapping measurements, the magnet was charged to 722 MHz which is the highest field to which the magnet could be charged at 4.2 K while still allowing a safe superconducting temperature margin. This test showed that the magnet could be successfully charged to 722 MHz in one day without quench. The magnet was held at 722 MHz to measure the persistence, which revealed a higher than desirable decay rate and presented our greatest challenge. Options have been developed to correct for this decay, and one of these options will be investigated in the next bucket test.

Finally, the test plan requires 2.3 K testing to 900 MHz. During ramp down from 722 MHz, however, a prohibitive boiloff rate of liquid helium appeared due to a developed resistance in the current lead jumpers that connect the vapor cooled leads to the superconducting magnet. This resistance does not affect the performance of the final magnet system, but did prohibit bucket tests at 2.3 K until the current lead jumpers could be modified. At this point, no more information could be obtained from the initial bucket test until some hardware modifications were made, and the bucket test assembly was warmed up to room temperature.

In summary, the initial bucket test has provided the opportunity to successfully tune the quench detection system, confirm that the homogeneity performance of the system will successfully meet its specification of 1 ppb over a 4 cm DSV, confirm successful operation to 722 MHz, and reveal the challenge of correcting for a higher than desirable decay rate. The next bucket test, scheduled for early summer 2002, is expected to confirm successful operation to 900 MHz and to investigate a method for successfully correcting for a higher than desirable drift rate.

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